Learning Laparoscopic Donor Nephrectomy Safely

A Report on 100 Cases

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Hypothesis: There is concern that learning laparoscopic live donor nephrectomy (LLDN) is associated with increased morbidity. We propose that with a team approach LLDN can be learned safely, without increased donor morbidity or graft failure, even during the early portion of a learning curve.

Design: Case series with cohort comparison.

Setting: Tertiary referral center.

Patients: The laparoscopic group consisted of 100 donors and 100 recipients; the open group, 50 donors and 50 recipients.

Interventions: A team approach that combines laparoscopic and urologic expertise was used to perform 100 cases of LLDN.

Main Outcome Measures: Donor morbidity and graft function in the laparoscopic group were compared with those in the open group.

Results: Laparoscopic live donor nephrectomy was completed in 99 patients. One patient required conversion to open donor nephrectomy because of intraoperative hemorrhage. Minor complications occurred in 6 laparoscopic group donors (6%) and 3 open group donors (6%). Operative times were longer for laparoscopic group donors (231 vs 209 minutes). Mean hospital stay was shorter for laparoscopic group donors (3.3 vs 4.7 days). Graft function was comparable between the laparoscopic and open groups, with equivalent postoperative creatinine levels. Graft survival was comparable. Recipient ureteral complications occurred with less frequency (2% vs 6%) in the laparoscopic group.

Conclusions: By forming an operative team that combines expertise in laparoscopy with expertise in live donor nephrectomy, surgeons can learn LLDN safely. Adoption of the techniques developed by those who pioneered the procedure can further minimize the morbidity associated with a learning curve.

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The need for donor renal grafts greatly outweighs the supply. Living donor renal transplantation is the preferred method because of improved graft function and survival compared with cadaveric kidney transplantation. A laparoscopic approach to live donor nephrectomy has been shown to decrease postoperative pain and hospital stay while hastening return to normal activity among donors. By removing disincentives from potential donors, this technique has the potential to expand the living donor pool, thereby helping to serve more of those in need of transplantation.

The first laparoscopic live donor nephrectomy (LLDN) was carried out by Ratner and colleagues in 1995. The procedure is currently practiced at many centers, but few have amassed a large experience. Concerns have been expressed regarding safety, particularly during the early learning of the procedure. In experienced hands, the morbidity and mortality of the procedure now equal that of open live donor nephrectomy (OLDN), but even the greatest advocates of LLDN have questioned the feasibility of exporting the procedure to other centers. Laparoscopic live donor nephrectomy is a technically demanding procedure requiring a major vascular dissection with temporary anticoagulation and rapid extraction of the kidney to minimize warm ischemia, all while tolerating no trauma to the organ. We present herein our experience with learning LLDN, with a review of our first 100 cases.

Table 1 relates patient demographics, perioperative data, and follow-up. Laparoscopic group donors tended to be of the same age and had the same HLA compatibility as open group donors. Operative times were longer in laparoscopic group donors, although blood loss and length of...
PATIENTS AND METHODS

PATIENTS

Beginning on October 1, 1998, individuals presenting to Virginia Mason Medical Center, Seattle, Wash, for left donor nephrectomy were offered LLDN vs OLDN. Laparoscopic live donor nephrectomy was not offered to those who were better suited for right donor nephrectomy. The presence of multiple renal vessels and obesity did not preclude a laparoscopic approach. The operative team for LLDN consisted of a transplant surgeon–urologist (T.L.H.) and a general surgeon with expertise in laparoscopy (T.R.B.). Comparison was made with 50 consecutive OLDNs performed since 1998 by 4 urologists at our institution (including T.L.H.).

Donor hospital stay, operative time, HLA compatibility, blood loss, and recipient postoperative creatinine levels were compared by t test. Sex distribution in the 2 donor groups was compared by the χ² test. A P value of <.05 was deemed statistically significant. Donor complications and graft survival were evaluated by a review of medical records, inquiry into the U Net database of the United Network for Organ Sharing, and in some cases by telephone interview.

OPERATIVE TECHNIQUE

Laparoscopic group donors are placed in the 45° lateral position with the right side down. Port placement is as illustrated in the Figure. The harmonic scalpel (Ethicon Endo-Surgery, Inc, Cincinnati, Ohio) is used to mobilize the entire left colon, spleen, and tail of pancreas medially. The renal vein’s tributaries are divided between clips, allowing its complete mobilization. The renal artery is dissected to its origin. The adrenal gland is separated from the kidney with the harmonic scalpel. The ureter is dissected en bloc with the gonadal vasculature and divided at the pelvic brim. A Pfannenstiel incision is made. Heparin sodium (5000 U) is given intravenously. The renal artery and vein are divided with a vascular stapler, and the donor kidney is manually delivered from the abdominal cavity through the Pfannenstiel incision. Open group donors underwent left (37 patients) or right (13 patients) donor nephrectomy through an extraperitoneal flank incision (48 patients) or a paramedian incision (2 patients).

All recipients underwent immediate transplantation through a standard extraperitoneal incision. Induction immunosuppression was tailored to the individual but most frequently progressed to maintenance therapy that included the administration of corticosteroids, mycophenolate mofetil, and cyclosporine therapy.

hospital stay were lessened compared with open group donors. Follow-up on graft function was longer in the open group, which reflects the increased use of LLDN at our institution during the past 2 years.

Laparoscopic live donor nephrectomy was completed successfully in 99 of 100 patients. One patient (the 41st) underwent conversion to OLDN to control an injury to an adrenal artery arising from the aorta; no transfusion was required and the postoperative course was uneventful.

Major vascular anomalies did not preclude successful performance of LLDN. In the laparoscopic group, 35 donors had renal vascular anomalies: 27 had 2 or more left renal arteries, 7 had retroaortic or circumaortic renal veins, and 2 had duplicated left renal veins. (One patient had more than 1 anomaly.) The presence of vascular anomalies did not affect warm ischemia time, operative time, or blood loss (Table 2).

There were no major complications among donors in either group. Minor complications occurred in 6 of 100 laparoscopic group donors (arterial injury requiring conversion to an open procedure, umbilical fascial dehiscence, ileus, nausea and vomiting requiring read-

![](image)

Trocar and incision sites.

Table 1. Donor Demographics, Perioperative Data, and Follow-up*

<table>
<thead>
<tr>
<th>Group</th>
<th>Laparoscopic (n = 100)</th>
<th>Open Group (n = 50)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Donor sex, No. M/F</td>
<td>40/60</td>
<td>30/20</td>
<td>.02</td>
</tr>
<tr>
<td>Donor age, y</td>
<td>41.1</td>
<td>40.9</td>
<td>.87</td>
</tr>
<tr>
<td>HLA mismatch, No.</td>
<td>2.4</td>
<td>2.7</td>
<td>.43</td>
</tr>
<tr>
<td>Operative time, min</td>
<td>231</td>
<td>209</td>
<td>.002</td>
</tr>
<tr>
<td>Estimated blood loss, mL</td>
<td>102</td>
<td>193</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Hospital stay, d</td>
<td>3.3</td>
<td>4.7</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Warm ischemia time, min</td>
<td>2.3</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Follow-up, d</td>
<td>230</td>
<td>331</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Data are given as mean values unless otherwise indicated. NA indicates not applicable.

Table 2. Effect of Renal Vascular Anomalies on Operative Time, Warm Ischemia Time, and Estimated Blood Loss*

<table>
<thead>
<tr>
<th>No Vascular Anomalies (n = 65)</th>
<th>Vascular Anomalies (n = 35)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative time, min</td>
<td>233</td>
<td>229</td>
</tr>
<tr>
<td>Warm ischemia time, min</td>
<td>2.3</td>
<td>2.3</td>
</tr>
<tr>
<td>Estimated blood loss, mL</td>
<td>107</td>
<td>92</td>
</tr>
</tbody>
</table>

*Data are given as mean values.
mission of the patient, wound infection, and prolonged flank pain in 1 patient each) and in 3 of 50 open group donors (pneumonia, wound infection, and ileus in 1 patient each).

Graft function was not impaired by laparoscopic procurement. Postoperative creatinine levels (Table 3) were comparable at postoperative days 1 and 5 and at 6 months. (Six-month follow-up data for the last 17 patients in the laparoscopic group were not yet available at the time of manuscript submission.)

Ureteral complications occurred in 2 (2%) of 100 laparoscopic group recipients and in 3 (6%) of 50 open group recipients. All of these patients required either reoperative ureteral repair or antegrade or retrograde ureteral stenting.

Graft survival was similar in the 2 groups. Three graft failures occurred among the 100 recipients in the laparoscopic group; these failures were due to rejection (2 patients) and renal vein thrombosis following cardiopulmonary arrest during seizure (1 patient). There was 1 graft failure among the 50 recipients in the open group. Two recipients in each of the groups died of unrelated causes. All other grafts were functioning at the time of last follow-up.

Safety was equivalent throughout the series and did not reflect a learning curve. Of the 6 complications among laparoscopic group donors, 3 occurred in the first 50 patients and 3 in the last 50 patients. Mean operative time and blood loss showed only minor downward trends with experience, whereas warm ischemia time showed significant improvement (Table 4).

**COMMENT**

Wolf and colleagues recently conducted a randomized controlled trial that confirmed what several previous reports using historical open controls had shown—that LLDN offers shorter donor convalescence than OLDN while providing equivalent graft function for recipients. Our experience adds to this body of literature.

Laparoscopic live donor nephrectomy has been well received among donors and recipients and may have the potential to expand the donor pool. However, the perceived difficulty in learning LLDN has slowed its wider implementation. Large series of LLDN have come from relatively few institutions. Early series were troubled with complications in up to 20% of donors. Indeed, many of the procedure's greatest proponents have expressed concern about safety during early learning. In an editorial that voiced general support of the laparoscopic approach, Fabrizio et al cautioned that "this has the potential to expose a large number of patients to the learning curve of each physician offering this technique."

Our experience shows that LLDN can be learned safely. The rate of minor donor complications in our laparoscopic series (6%) compares favorably with that of our open group, as well as that of another larger series of OLDN. We were unable to detect any adverse effect of laparoscopic procurement on graft function. Complex renal vascular anatomy did not affect safety. Although unusually high rates of ureteral complications (up to 13%) have been reported in the early part of a large series of LLDN, our series had only a 2% incidence, which was less than that of our open group. The complications that did occur were evenly spaced throughout the series, again suggesting no significant effect of the learning curve.

Of interest, there was little decrease in operative times during the series. An initial drop was followed by a plateau as we began to allow trainees to perform more of the procedure. The one factor that showed a statistically significant improvement by the end of the series was warm ischemia time. This finding is partly attributable to a change in technique for retrieval of the graft. After our 43rd patient, we dropped the use of a laparoscopic self-deploying bag in favor of direct manual extraction, which we found to be less cumbersome, more reliable, and quicker.

We attribute our success to 2 factors. First, we were able to learn from the experience of those who pioneered the procedure at The Johns Hopkins University, Baltimore, Md, and the University of Maryland, Baltimore. We learned techniques these pioneers had developed by reading their published reports. Our experience shows that LLDN can be learned safely. The rate of minor donor complications in our laparoscopic series (6%) compares favorably with that of our open group, as well as that of another larger series of OLDN. We were unable to detect any adverse effect of laparoscopic procurement on graft function. Complex renal vascular anatomy did not affect safety. Although unusually high rates of ureteral complications (up to 13%) have been reported in the early part of a large series of LLDN, our series had only a 2% incidence, which was less than that of our open group. The complications that did occur were evenly spaced throughout the series, again suggesting no significant effect of the learning curve.

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**Table 3. Mean Creatinine Levels Before and After Surgery in Recipients by Method of Procurement**

<table>
<thead>
<tr>
<th>Creatinine Level, mg/dL*</th>
<th>Laparoscopic Group</th>
<th>Open Group</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before surgery</td>
<td>8.37</td>
<td>8.46</td>
<td>.87</td>
</tr>
<tr>
<td>After surgery</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 d</td>
<td>4.01</td>
<td>3.85</td>
<td>.64</td>
</tr>
<tr>
<td>5 d</td>
<td>1.47</td>
<td>1.42</td>
<td>.69</td>
</tr>
<tr>
<td>6 mo</td>
<td>1.64</td>
<td>1.48</td>
<td>.26</td>
</tr>
</tbody>
</table>

*To convert creatinine to micromoles per liter, multiply by 88.4.

**Table 4. Operative Factors in First and Last Quarters of the Series**

<table>
<thead>
<tr>
<th></th>
<th>First 25 Patients</th>
<th>Last 25 Patients</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operative time, min</td>
<td>232</td>
<td>221</td>
<td>.29</td>
</tr>
<tr>
<td>Estimated blood loss, mL</td>
<td>94</td>
<td>88</td>
<td>.58</td>
</tr>
<tr>
<td>Warm ischemia time, min</td>
<td>3.3</td>
<td>1.8</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

*Data are given as mean values.

This study was presented at the 109th Scientific Session of the Western Surgical Association, San Antonio, Tex, November 14, 2001.
In the evolution of this procedure there have been, as was mentioned, a number of problems associated with LDN that have been overcome. There was the issue of ureteral complications and the issue of extraction. Most programs now have abandoned bag extraction and have gone to manual extraction. Currently, right LDN remains somewhat controversial, as only about 10% of LDN programs will perform a right LDN. This is because of the very short vascular pedicles that you get and a more difficult dissection of the right artery behind the vena cava. There is also the issue of vascular anomalies—the issues of how many vessels are you willing to take and what different types of vessels, such as a very small inferior pole vessel, are you willing to take? And, is the use of interposition grafts acceptable? When you look in the literature, there is no mention of the use of interposition grafts; however, they are used with increasing frequency and we know that they have been used in the University of Maryland program.

Finally, there is the issue of the obese donor. Paul Kuo, from Georgetown University, has a small series in the literature documenting that this procedure can be performed in patients with a greater degree of obesity than has traditionally been accepted for open procedures, but the upper limits of that have not been defined.

My questions are these: (1) The hospital stay of 3.3 days appears to be a little bit long. I think this may be a statistical issue, and I would be interested to know what the median length of stay was and what percentage of patients actually went home within 48 hours. (2) I would also like to know a little more about the vascular anomalies and ask the authors if they did exclude some patients. For example, I noticed there were no patients with 3 arteries. (3) Also, I would like to know if they have 2 arteries and they are separated by a large distance and it is known that there is a high chance that they would have to use an interposition graft, would they go ahead and take that kidney? (4) I would also like to know if they have used interposition grafts in recipients and, also, have they modified the recipient procedure to deal with the shorter vessels that are generally generated with laparoscopic nephrectomy? (5) I would like to know if they did right LDN. Are they currently doing them? Do they plan to do them? (6) I would also ask them the question, how many open donor nephrectomies were done during this period of time, and are they continuing to do open donor nephrectomies or do they plan to abandon this procedure?

Finally, I would just make a comment that, in general, anticoagulation of the donor is not needed in our program. We heparinize the perfusion solution and avoid heparinization of the donor.

Dr Bielh: Before I answer Dr Woodle's questions, I wanted to make a few comments. First of all, this is a high-risk operation with potential to harm both the donor and the graft, in other words, 2 patients. I frequently tell the residents and fellows that the absolute best we can do for the donor is to make him/her worse; it is just a question of how much worse. In that regard, I believe that there should be zero tolerance for error. It requires very careful planning and careful dissection, both early and late in one's experience.

I was asked recently what I thought the learning curve is. How many cases should it take to be good at this? The learning curve should and has to be zero. Patients perceive the operation as “less invasive,” but it is easier to get into trouble and harder to get out. Patients should understand this.

Let me get to the questions now. Specifically with regard to hospital stay, yes, the average was 3.3 days, which was not that much different from the open procedure—about 1.5 days less. This has to do with what we discussed yesterday. If you tell a patient preoperatively that they are going to go home in 2 days, they will go home in 2 days. We do not frequently do that, but...
have started. I don’t actually know what the median stay is, but it is probably 3 days. Many of our patients actually come from very far away, and they want to stay in the hospital because their loved one is there and they want to see them recover.

With regard to multiple arteries, we actually don’t exclude anyone now. We did have one patient with 3 arteries. Unless a vessel is too small to use, it is reimplanted. For the most part when we have 2 vessels, they are put together like a pair of pants and then reimplanted as one.

We have not used any interposition grafts, and I believe that is because the vessels are actually not shorter than what we are getting in the open cases. We are very careful to dissect the artery all the way to its origin from the aorta and very careful also with the vein to get as much length as possible, dividing it distal to the insertion of the adrenal vein, so between the adrenal vein and the vena cava. For this reason, we have not done any right-sided kidneys, mostly because it is easier to transplant a left-sided kidney with its associated larger vessels. As far as the number of open cases during the same time, it was actually 50. We chose those 50 for comparison because we wanted to compare cases done during the same period of time.

The need for heparin: that was standard beforehand. The transplant surgeon that I work with thinks it is important. It doesn’t appear to have any deleterious effects. The patient is heparinized only for a very short period of time. We give heparin, wait about 3 minutes, and as soon as the artery is divided, we reverse the heparin with protamine. We have not noticed any significant blood loss with that, but you may be right and it may be unnecessary.

### Archives of Internal Medicine

**Pattern of Primary Resistance of Helicobacter pylori to Metronidazole or Clarithromycin in the United States**

*Michael S. Osato, PhD; Rita Reddy, MS; Siddharta G. Reddy, BS; Rebecca L. Penland, BS; Hoda M. Malaty, MD, PhD; and David Y. Graham, MD*

**Background:** Therapy for *Helicobacter pylori* is generally empiric despite the fact that resistance to metronidazole and clarithromycin compromise therapeutic efficacy. The aim of this study was to aid clinicians in choosing a course of therapy for *H pylori* infection in the United States.

**Methods:** The frequency of primary clarithromycin and metronidazole resistance among *H pylori* isolated from patients enrolled in US-based clinical trials between 1993 and 1999 was reviewed in relation to patient age, sex, region of the United States, and test method (Etest and 2 agar dilution procedures).

**Results:** Clarithromycin and metronidazole resistance rates were based on the results of 3439 pretreatment Etest determinations and 3193 agar dilution determinations. Sex and age were available on 900 and 823 individuals, respectively. Metronidazole resistance was 39% by Etest and 21.6% by agar dilution (*P*<.001). Clarithromycin resistance was 12% by Etest and 10.6% by agar dilution. Amoxicillin or tetracycline resistance was rare. Metronidazole and clarithromycin resistance was more common in women than men (eg, 34.7% vs 22.6% for metronidazole and 14.1% vs 9.7% for clarithromycin (*P*=.01 and *P*=.06, respectively). Antibiotic resistance increased gradually up to age 70 years, then declined significantly (*P*<.05) regardless of test method. Regional differences in antimicrobial resistance did not occur.

**Conclusions:** While age and sex had significant effects on resistance rates, regional differences were not present. The high prevalence of resistance to metronidazole and clarithromycin may soon require the performance of antimicrobial susceptibility testing of *H pylori* isolates prior to initiating treatment. (2001;161:1217-1220)

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